IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY PATENT
APPLICATION TRANSMITTAL LETTER

Box PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed for filing is the utility patent application of <u>Robert J. MARTIN</u> for <u>TWO COLOR QUANTUM WELL FOCAL PLANE ARRAYS</u>.

Also enclosed are:

[x] ___2___ sheet(s) of [ ] formal [x] informal drawing(s);

[ ] a claim for foreign priority under 35 U.S.C. §§ 119 and/or 365 is [ ] hereby made to _
filed in _ on _;
[ ] in the declaration;

[ ] a certified copy of the priority document;

[ ] a General Authorization for Petitions for Extensions of Time and Payment of Fees;

[ ] _____ statement(s) claiming small entity status;

[x] an Assignment document;

[ ] an Information Disclosure Statement; and

[ ] Other: _____.

[x] An [x] executed [ ] unexecuted declaration of the inventor(s)
[x] also is enclosed [ ] will follow.

[ ] Please amend the specification by inserting before the first line the sentence --This
application claims priority under 35 U.S.C. §§119 and/or 365 to _ filed in _ on _; the
entire content of which is hereby incorporated by reference.--

[ ] A bibliographic data entry sheet is enclosed.

21839

(2/00)

[ ]   The filing fee has been calculated as follows [ ] and in accordance with the enclosed preliminary amendment:

CLAIMS				
	NO. OF CLAIMS		**EXTRA CLAIMS**	**RATE**	**FEE**
Basic Application Fee				$690.00 (101)
Total Claims	4	MINUS 20 =		x $18.00 (103)	
Independent Claims	2	MINUS 3 =		x $78.00 (102)	
If multiple dependent claims are presented, add $260.00 (104)				
Total Application Fee				
If verified Statement claiming small entity status is enclosed, subtract 50% of Total Application Fee				
Add Assignment Recording Fee if Assignment document is enclosed				40.00
TOTAL APPLICATION FEE DUE				$730.00

[ ]   This application is being filed without a filing fee. Issuance of a Notice to File Missing Parts of Application is respectfully requested.

[x]   A check in the amount of $ __730.00__ is enclosed for the fee due.

[ ]   Charge $ _____ to Deposit Account No. 02-4800 for the fee due.

[X]   The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§ 1.16, 1.17 and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. This paper is submitted in duplicate.
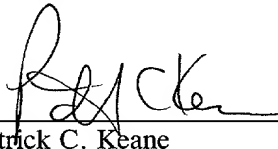
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Respectfully submitted,

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(2/00)

APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

TWO COLOR QUANTUM WELL
FOCAL PLANE ARRAYS

by
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Attorney's Docket No. 017750-506

TWO COLOR QUANTUM WELL FOCAL PLANE ARRAYS

The present application is related to Application Serial No. _____
(Attorney Docket No. 017750-410), entitled "Three Color Quantum Well Focal Plane
Arrays", Application Serial No. _____ (Attorney Docket No. 017750-
442), entitled "Programmable Hyper-Spectral Infrared Focal Plane Array," Application
Serial No._____ (Attorney Docket No. 017750-444), entitled
"Remote Temperature Sensing Long Wavelength Modulated Focal Plane Array,
Application Serial No. _____ (Attorney Docket No. 017750-443); entitled
"Clutter Discriminating Focal Plane Array," and Application Serial No.
_____ (Attorney Docket No. 017750-447), entitled "Large Dynamic Range
Focal Plane Array," all filed on even data herewith. The disclosures of the above
identified Patent Applications are herein incorporated by reference.

BACKGROUND OF THE INVENTION

1. **Field of the Invention**

The present invention is directed generally to quantum well infrared photodetector
focal plane arrays (QWIP FPA's) and, more particularly, to QWIP FPAs that are capable
of multicolor detection.

2. **Background Information**

Multicolor infrared detection capability has wide applicability to a number of
different applications including aerospace, medical, surveying, mining, and agriculture.
For example, multicolor infrared detection can provide useful information during
geographical surveys. Detection in at least two infrared (IR) spectral bands could permit
differentiation between man-made structures and natural landscape in a geographical
survey. Additionally, in medical applications, multi-color detection would permit
improved thermal imaging of the human body for diagnostic purposes.

Multicolor infrared detection has been conventionally performed using a wide-
band IR detector and an associated rotating mechanical multicolor filter wheel. The wide-
band IR detector detects a broad range of incident wavelengths. The rotating filter wheel

selects the desired wavelength that is to be passed to the wide-band detector. An exemplary mechanical color filter wheel system is disclosed in U.S. Patent No. 5,300,780. Mechanical color wheel systems, however, suffer from a number of deficiencies in multicolor detection. Such systems generally are slow and bulky, require large amounts

5   of power for operation, and have a limited life span. Additionally, color wheel systems tend to have poor photon collection efficiency.

To alleviate some of the known deficiencies of mechanical color filter wheel systems, quantum well photodetectors have been constructed that permit the detection of more than one spectral band. Such detectors are described, for example, in U.S. Patent

10   Nos. 5,013,918, 5,198,659, and 5,384,469. These patents generally disclose the use of a plurality of quantum well sets within a single detector where the frequency response characteristics of each quantum well in the set is tailored by adjusting the well depths. The detectors in these patents are designed for use with a single bias voltage that is applied across all the quantum wells of the set. Thus, each quantum well that is "tuned"

15   to a specific frequency band can not have its bias adjusted independent of any other "tuned" quantum well in the set. The output voltage responses for each of the "colors" in the detector will therefore be nonuniform for any given background photon flux. In addition, the detectors of these patents provide only a single detected output signal composed of multi-spectral frequency components. Extraction of different frequency

20   bands from the single output therefore requires additional filtering.

Accordingly, there exists a need in the art for a quantum well photodetector that has multi-color capability but which can also provide independent bias adjustment for each color and which can independently and simultaneously process the outputs of each of the colors of the detector.

25   **SUMMARY OF THE INVENTION**

Exemplary embodiments of the present invention use a vertically stacked quantum well infrared detector where each "tuned" quantum well of the detector can be biased separately from any other quantum well of the detector. The vertically stacked detector can include two quantum well layers that are "tuned" to different peak

wavelengths to permit detection of infrared radiation of two different bands or colors. Simultaneous detection in two spectral bands permits the determination of more information about an infrared source.

5   The present invention is directed to a photodetector comprising: a first quantum well layer; a second quantum well layer, wherein said first quantum well layer is formed atop said second quantum well layer; and means for independently biasing said first and second quantum well layers. The present invention is additionally directed to a method of fabricating such a photodetector.

10   The present invention is also directed to a photodetector comprising: first means responsive to impinging energy of a first spectral band; and second means responsive to impinging energy of a second spectral band, wherein said impinging energy of said second spectral band first passes through said first means before reaching said second means, and further wherein said first means provides a first quantity of moving charges to a first output of said photodetector and said second means provides a second quantity of

15   moving charges to a second output of said photodetector.

      Exemplary embodiments of the present invention are also directed to a circuit for varying the integration time of moving charges from a photodetector comprising: a first charge well for receiving moving charges from a photodetector; at least one additional charge well; and means for selectively switching said at least one additional charge well

20   in parallel with said first charge well to vary the integration time of said moving charges.

      The present invention is further directed to a method of varying the integration time of moving charges from a photodetector comprising the steps of: supplying moving charges from a photodetector to an integration capacitance; and selectively varying said integration capacitance to vary the integration time of said moving charges.

25   **BRIEF DESCRIPTION OF THE DRAWINGS**

      Other objects and advantages of the invention will be apparent to those skilled in the art reading the following detailed description of the preferred embodiments in conjunction with the drawings in which like reference numbers have been used to indicate like elements and wherein:

FIG. 1 is a structural diagram of a two color quantum well detector in accordance with an exemplary embodiment of the present invention; and

FIG. 2 is a schematic of the readout circuit in accordance with an exemplary embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Multicolor detection in exemplary embodiments of the invention is achieved by adjusting depths of the one or more quantum wells associated with each spectral band of a detector. Based on well known physical principles, the vertical depth of the one or more quantum wells comprising a photosensitive layer of a detector determines the energy required from impinging photons to permit carriers in the well to escape for conduction. The vertical depth of each quantum well thus determines the spectral response of the photosensitive layer to radiation in the form of impinging photons of various wavelengths. The allowed energy states in a quantum well are:

$$E_n = \frac{h^2 n^2}{8ml^2} \qquad \text{joules} \qquad \text{Eqn. (1)}$$

where h is Planck's constant=$6.626*10^{-34}$ joule*seconds
m is the effective mass of the carrier
n is an integer n=1, 2, 3...
E_n is the energy of a given band in Joules
l is the depth of the quantum well in meters.

For a carrier to move between the valence band (n=1) and the conduction band (n=2), the following energy $E_{1,2}$ is required to free the carrier from the valence band:

$$E_{1,2} = E_g = \frac{h^2(2^2-1^2)}{8ml^2} = \frac{3h^2}{8ml^2} \qquad \text{joules} \qquad \text{Eqn. (2)}$$

The energy required to free the carrier from the valence band to the conduction band ($E_{1,2}$) is alternatively called the energy gap, E_g. The energy given up by an impinging photon

must be equal to or larger than the energy gap (E_g). Photon energy (E_p) is related to the wavelength of the photon by the following:

$$E_p = \frac{hc}{\lambda_p} \qquad \text{joules} \qquad \text{Eqn. (3)}$$

where h is Planck's constant=$6.626*10^{-34}$ Joule*seconds
c is the velocity of light = $3*10^8$ meters/second (in a vacuum)
λ_p is the peak wavelength corresponding to the middle of the band in meters.

By setting the photon energy (E_p) equal to the energy gap (E_g) between the bands, the relationship of the well depth to the peak wavelength needed to free carriers is demonstrated:

$$\lambda_p = \frac{8mcl^2}{3h} \qquad \text{meters} \qquad \text{Eqn. (4)}$$

Equation 4 is based on a general model, and those skilled in the art will recognize that other factors can influence the proportionality constant between wavelength and well depth. However, the peak wavelength can generally be considered proportional to the well depth:

$$\lambda_p = a_o l^2 \qquad \text{meters} \qquad \text{Eqn. (5)}$$

where a_o is a proportionality constant

Thus, as is apparent from Equation 5, the spectral response of a quantum well layer can be "tuned" to the desired peak wavelength by adjusting the depths of the one or more wells comprising the layer.

Figure 1 illustrates an exemplary embodiment of a dual color detector in accordance with the invention where two vertically stacked quantum wells have been "tuned" to different spectral bands or "colors" by adjustment of the depths of the quantum wells comprising each photosensitive layer of the detector. This dual color detector is

formed using a first means responsive to impinging energy, or radiation, of a first spectral band, represented in the Figure 1 embodiment as quantum well layer **100**. Quantum well layer **100**, comprising one or more quantum wells of a first depth, is layered over a second means responsive to impinging energy, or radiation, of a second spectral band,

5   represented in the Figure 1 embodiment as second quantum well layer **105**. Second quantum well layer **105** further comprises one or more quantum wells of a second depth. The first means is formed adjacent the second means such that impinging energy in the second spectral band first passes through the first means before reaching the second means.

10   Using known molecular beam epitaxy (MBE) techniques, the layers of the detector can be fabricated using the following exemplary process. First, an etch stop layer **110** is formed using a material such as AlGaAs, for example, and then a first contact layer **115**, doped to a first conductivity ,is formed upon a surface of the etch stop layer **110**. Next, a first quantum well layer **105** comprising one or more quantum wells of a depth

15   corresponding to a first desired peak wavelength is formed over the first doped contact layer **115**. A second contact layer **120**, doped to a second conductivity, is next formed over the first quantum well layer **105**. A second quantum well layer **100**, comprising one or more quantum wells of a depth corresponding to a second desired peak wavelength, is then formed over the second doped contact layer **120**, followed by a third contact layer

20   **125**, doped to a third conductivity. The formation of each layer of the detector can be performed using any conventional techniques appropriate for the layer being established including, but not limited to, growth or deposition techniques.

    Quantum well layers **100** and **105** can include multiple sublayers composed of alternating barrier sublayers and quantum well sublayers such as, for example, 20-period

25   GaAs/Al$_x$Ga$_{1-x}$As multi-quantum well stacks with the GaAs well depths and Al compositions adjusted to yield the desired peaks and spectral widths. One skilled in the art will recognize, however, that other multi-quantum well stacks can be used such as, for example, those disclosed in U.S. Patent No. 5,539,206 to Schimert, the disclosure of which is incorporated by reference herein. Furthermore, first contact layer **115**, and

contact layers **120** and **125** can be composed of doped GaAs (e.g., *n*+ GaAs), for example, though one skilled in the art will recognize that other suitable contact layer materials can be used. One skilled in the art will further recognize that various doping concentrations for the quantum wells and contact layers can be used in the present invention such as, for example, the doping concentrations disclosed in the above-identified U.S. Patent to Schimert.

Referring to Figure 1, the electrical connection for interfacing between the detector structure and the read out integrated circuit (ROIC) (not shown) of one exemplary embodiment can be seen. As illustrated in the Figure, an electrical contact **130** is connected to the second contact layer **120** for connection to the common bias voltage (DETCOM) of the Read Out Integrated Circuit (ROIC). Electrical contacts **135** and **140** are further connected to contact layers **125** and **120**, respectively, for connection to individual detector bias voltages supplied by the ROIC. The difference between the common bias voltage and the individual bias voltages supplied by the ROIC to each of the electrical contacts **135** and **140** establishes different bias voltages across each of the quantum well layers **100** and **105** of the detector. Electrical contacts **135** and **140**, each being associated with a different one of the quantum well layers **100** and **105**, thus provide means for biasing each band independently in conjunction with the individual detector bias voltages supplied by the ROIC. During operation, electrical contacts **135** and **140** additionally constitute outputs of the detector which supply photocurrent from each quantum well to the ROIC circuitry associated with each vertically stacked detector. Electrical contacts **130**, **135**, and **140** can be, for example, composed of Indium "bumps," or as any conventional contact known to those skilled in the art.

In an alternate exemplary embodiment, the two quantum well layers **100** and **105** are grown to produce long-wave spectral responses. The one or more quantum wells of first quantum well layer **105** are each grown to a specified depth to produce a desired peak spectral response (for example, a response at 8.6μm) and the one or more quantum wells of the second quantum well layer **100** are each grown to produce a different peak spectral response (for example, a response at 11.2μm). Each quantum well layer can be composed

of, for example, a 20-period GaAs/$Al_xGa_{1-x}As$ multi-quantum well stack with the GaAs well depths and the Al compositions adjusted to yield the desired peak and spectral width. The barriers of the quantum wells comprise compositions of predetermined thicknesses to provide sufficient isolation of each quantum well from adjacent quantum wells (for

5   example, ~550-600Å thick undoped AlGaAs). The GaAs wells are further doped with Si, for example, to provide ground state electrons. The first quantum well layer **105** is stacked on top of the second quantum well layer **100**, with an ohmic contact layer **120** of doped material (for example, doped GaAs) separating the two. An ohmic contact layer **115** of doped Gas below the second quantum well layer **105** and another doped GaAs

10   ohmic contact layer above the first quantum well layer **100** complete the detector structure. An etch stop layer **110**, comprising, for example, two AlGaAs etch stop layers (not shown) separated by an isolation layer of undoped GaAs (not shown), is formed beneath the dual quantum well structure.

         The GaAs/AlGaAs materials described above permit the realization of quantum

15   wells with peak wavelengths longer than approximately 6.5μm. Other exemplary embodiments may use different material systems to provide shorter or longer peak wavelengths. For example, using strained InGaAs in the quantum wells allows peak wavelengths as short as approximately 4.5μm. Wavelengths shorter than approximately 4μm can further be achieved using the lattice-matched InGaAs/InAlAs/InP material

20   system.

         A read out circuit of an exemplary embodiment of the invention is illustrated in Figure 2. This circuit performs a number of advantageous functions in the photon detection and read out process. One function performed is integration of the detector output for the duration of the next image frame while the current image frame is being

25   "read" at the output of the read out circuit. Every collected signal photon in the detector is precious when an infrared source is at a great distance, and thus, by integrating over the full frame time, the maximum number of electrons is collected. Referring to Figure 2, integration of the quantum well output for the each image frame is performed by charge well capacitances C_{w1} **200**, C_{w2} **205**, and reset voltage RST **210**.

Application and removal of RST voltage **210** permits the charge well capacitances to charge and discharge the electrons from the quantum well **215**, thus integrating the quantum well output. The integrated output of the quantum well is then selectively applied to the subsequent sample and hold circuitry by sample switching voltage SMP

5   **220**. Storage capacitor C_h **225** stores the integrated output of the quantum well so as to provide the read out for the current image frame at $Out_{1,2}$ **230**. The dump, ramp, and sample process performed by the Reset voltage RST **210**, the charge wells C_{w1} **200** and C_{w2} **205**, the quantum well detector resistance **215**, and the storage capacitance C_h **225** emulates an ideal noise filter if the charge well and storage capacitor sizes are properly

10   selected. A signal to noise improvement equal to the square root of three is available with this technique.

      The integration process discussed above also performs a second advantageous function - a "non-destructive" read. A "non-destructive" read occurs because the electron charge stored in the storage capacitor C_h **225** is not removed until electrically

15   connected in parallel with the charge well C_{w1} **200** and C_{w2} **205**. When the sample SMP voltage **220** is applied at the gate of M5 **235**, the electrical connection between the charge well and the storage capacitor is made and "charge sharing" occurs. This "charge sharing" produces a very mild image smoothing effect.

      A third advantageous function performed by the exemplary read out circuit of

20   Figure 2 is the improvement of the gain and dynamic range of the read out circuit through the use of two charge wells. At long ranges with faint targets, the number of volts per electron becomes a significant factor and signal to noise ratios thus become critical. As a hot target gets closer, the need changes from the need for maximizing the noise to avoiding saturation due to the very large number of target electrons rapidly

25   filling the charge well. The exemplary read out circuit of Fig. 2 solves this problem by augmenting the integration time through a change in the charge well capacitance. This is illustrated in Figure 4 by the use of the two charge well capacitances C_{w1} **200** and C_{w2} **205**. Application of a gain switching voltage GN **240** switches in the smaller charge

well capacitance C_{w2} **205** to add another twenty decibels of dynamic range to the system's performance. A high total dynamic range performance of 128 decibels can thus be realized (68 dB small well, 40 dB integration time modulation, and 20 dB well change).

5   A fourth advantageous function of the read out circuit is the balancing of the output voltage response for each of the colors through the use of independent bias adjustment. Balance is achieved by allowing independent bias adjustment for each color, thus permitting a uniform output voltage response for each of the colors for any given background photon flux. This adjustment is shown in Figure 2, as the BIAS input 10   **245**.

An additional advantageous function of the read out circuit is the removal of distortions in low level signals, due to current flowing in the ground reference, by the use of full difference mode outputs. Most power supply noise, ground noise, and induced pickup occurs as common mode noise. The use of difference amplifiers allows 15   these signals to be removed by subtraction. Difference amplifiers are well known in the art and thus have been omitted from the circuitry depicted in Figure 2.

Another advantageous function of the read out circuit is the elimination of electronic cross coupling. Electronic cross coupling can be avoided by having each color of the detector use its own time division multiplexer and output port. Since most 20   electronic cross talk in time division multiplexers is capacitive, use of very low driving point impedance in the line and column process is important in holding down the temporal-spectral cross talk. This is particularly imperative in high speed applications with wide dynamic range requirements. These characteristics can be achieved, as shown in Figure 4, through the use of the dual FET M7 **250** and push/pull operational 25   amplifier **255**. The dual FETs **250** open or close based on time division multiplexing voltages LINE **260** or COLUMN **265**. The LINE **260** voltage is used to access a line of cells in the focal plane array and the COLUMN **265** voltage accesses a column of cells

in the focal plane array. The push/pull operational amplifier **255** additionally sets the voltage gain of the output circuit to the following relationship:

5

$$\frac{V_o}{V_i} = \frac{R_F}{R_I(1+\frac{R_F}{R_I})} \qquad \text{Eqn. (6)}$$

The driving point impedance is further set by the resistor R_o **270**.

In an additional exemplary embodiment of the invention, higher density focal plane arrays may be produced by removing the charge wells from the ROIC and

10 fabricating the charge wells within the detector structure itself. The smaller pitch required of higher density arrays limits the usable area available for the charge wells in the ROIC underlying the detector structure. By fabricating the charge wells integrally to the detector itself, less space is required in the underlying ROIC and therefore higher densities can be achieved in the array. The technique of using integral charge wells is

15 disclosed in U.S. Patent Application No. 09/149,483, entitled "Integral Charge Well for QWIP FPA's," the disclosure of which is herein incorporated by reference.

Optical coupling, in accordance with exemplary embodiments of the invention, can be achieved using a number of different techniques. Principles of quantum selection require that incident electromagnetic fields propagate in the horizontal plane of the

20 quantum well. The incident flux must therefore be reflected inside the quantum well at an angle such that the flux passes through the material many times. In one exemplary embodiment, a rotated waffle diffraction grating is used, where the width of the waffle corresponds to one wavelength, the length of the waffle to another, and the diagonal to a third wavelength. The waffle grating, combined with a top side grating and side wall

25 reflecting mirrors, constitute the optimum "photon in a box" quantum well detector optical system. Additionally, the waffle grating can be enhanced with a flux entry side anti-reflective coating composed of, for example, a quarter wavelength dielectric material. In addition to the waffle grating, one skilled in the art will recognize that a number of different techniques can be used for achieving optical coupling in the present invention.

Such techniques include use of random gratings, reflectors, resonance structures, and so forth.

One skilled in the art will recognize that multiple stacks of the two-color detector of the present invention can be used in a focal plane array for multi-color detection. Multi-color detection can be achieved by formation of multiple stacks of two layer quantum wells on a common substrate, with the depths of each well "tuned" to the appropriate peak wavelength. For example, a threesome of two layer detector structures can be used to detect six different spectral bands by "tuning" each of the quantum well layers in the three different vertically stacked structures to different peak wavelengths. Thus, in such an embodiment, three two layer detector structures can be used in tandem to simultaneously detect six different spectral bands.

As one skilled in the art will recognize, a plurality of the vertically stacked detector structures described in the exemplary embodiments above can be formed across an etch stop layer to provide a detector structure array. This array will serve as a focal plane for optics of an IR imaging system. Such optics are conventionally known in the art and are not described here.

One skilled in the art will additionally recognize that the detector and ROIC can be fabricated as integral structures in the focal plane array. Using this fabrication technique, the detector and read out circuitry can be fabricated as a unitary structure, thus removing the need for aligning the detector array structure and the ROIC array structure so as to connect each ROIC, via conductive bumps, with its associated detector across the array.

It will be appreciated by those skilled in the art that the present invention can be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The presently disclosed embodiments are therefore considered in all respects to be illustrative and not restricted. The scope of the invention is indicated by the appended claims rather than the foregoing description and all changes that come within the meaning and range and equivalence thereof are intended to be embraced therein.

What is Claimed is:

1.   A circuit for varying the integration time of moving charges from a photodetector comprising:

   a first charge well for receiving moving charges from a
   photodetector;

   at least one additional charge well; and

   means for selectively switching said at least one additional
   charge well in parallel with said first charge well to
   vary the integration time of said moving charges.

2.   The circuit of claim 1, wherein said first charge well comprises a capacitor.

3.   The circuit of claim 1, wherein said at least one additional charge well comprises a capacitor.

4.   A method of varying the integration time of moving charges from a photodetector comprising the steps of:

   supplying moving charges from a photodetector to an integration
   capacitance; and

   selectively varying said integration capacitance to vary the integration time
   of said moving charges.

Abstract

An infrared photodetector includes at least two quantum well layers with depths adjusted to provide different peak spectral responses. Adjustment of the depths of the quantum well layers permits the photodetector array to receive and process two or more different infrared colors so as to provide additional infrared information.
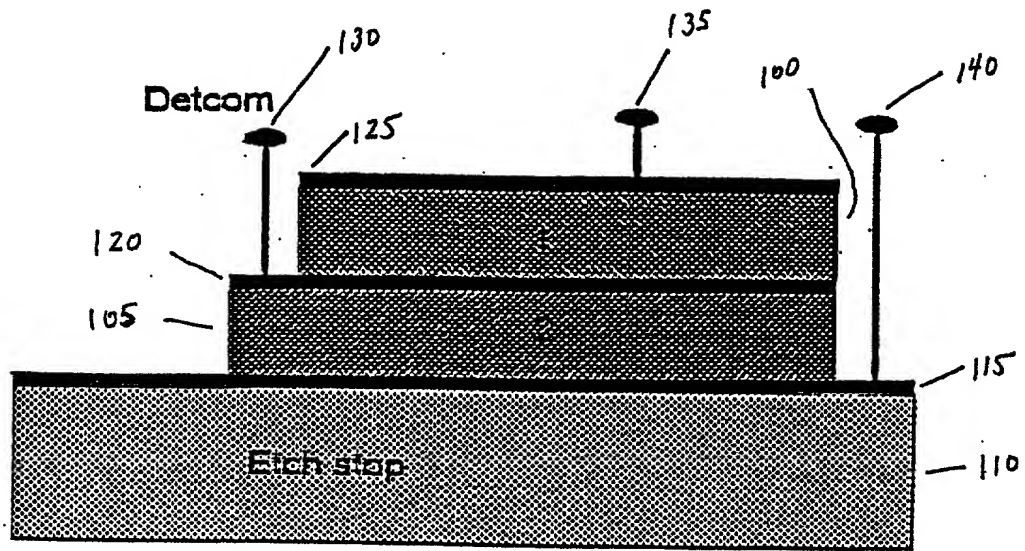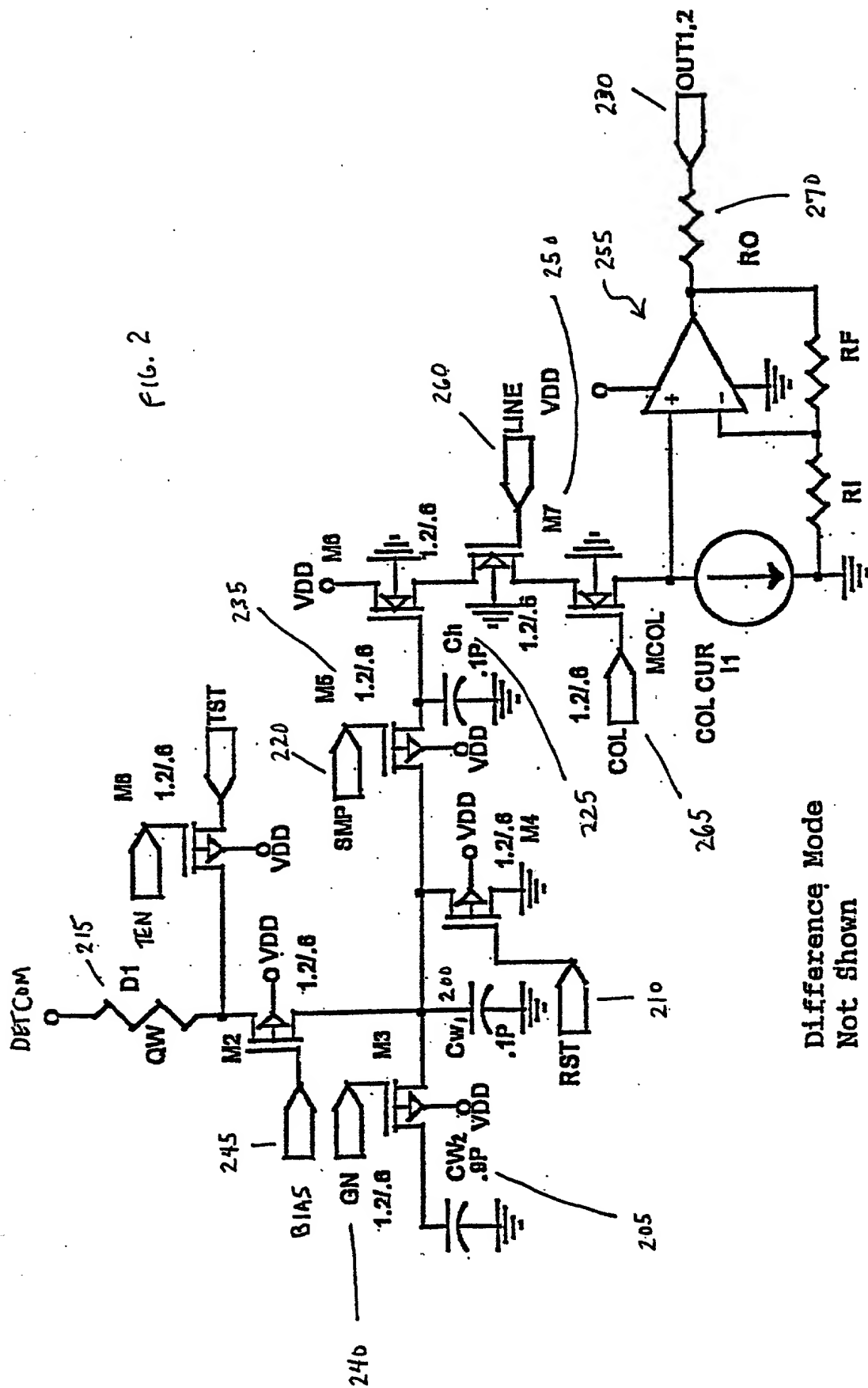
FIG. 1

FIG. 2

Difference Mode
Not Shown

COMBINED DECLARATION AND POWER OF ATTORNEY FOR UTILITY PATENT APPLICATION	Attorney's Docket No.
	017750-506

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I BELIEVE I AM THE ORIGINAL, FIRST AND SOLE INVENTOR (if only one name is listed below) OR AN ORIGINAL, FIRST AND JOINT INVENTOR (if more than one name is listed below) OF THE SUBJECT MATTER WHICH IS CLAIMED AND FOR WHICH A PATENT IS SOUGHT ON THE INVENTION ENTITLED:

TWO COLOR QUANTUM WELL FOCAL PLANE ARRAYS

the specification of which

(check one)   ☒   is attached hereto;

    ☐   was filed on _____ as

Application No. _____

and was amended on _____ ;
                            (if applicable)

I HAVE REVIEWED AND UNDERSTAND THE CONTENTS OF THE ABOVE-IDENTIFIED SPECIFICATION, INCLUDING THE CLAIMS, AS AMENDED BY ANY AMENDMENT REFERRED TO ABOVE;

I ACKNOWLEDGE THE DUTY TO DISCLOSE TO THE OFFICE ALL INFORMATION KNOWN TO ME TO BE MATERIAL TO PATENTABILITY AS DEFINED IN TITLE 37, CODE OF FEDERAL REGULATIONS, Sec. 1.56 (as amended effective March 16, 1992);

I do not know and do not believe the said invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to said application; that said invention was not in public use or on sale in the United States of America more than one year prior to said application; that said invention has not been patented or made the subject of an inventor's certificate issued before the date of said application in any country foreign to the United States of America on any application filed by me or my legal representatives or assigns more than twelve months prior to said application;

I hereby claim foreign priority benefits under Title 35, United States Code Sec. 119 and/or Sec. 365 of any foreign application(s) for patent or inventor's certificate as indicated below and have also identified below any foreign application for patent or inventor's certificate on this invention having a filing date before that of the application(s) on which priority is claimed:

(5/00)

COMBINED DECLARATION AND POWER OF ATTORNEY	Attorney's Docket No. 017750-506

COUNTRY/INTERNATIONAL	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			YES_ NO_
			YES_ NO_

I hereby appoint the following attorneys and agent(s) to prosecute said application and to transact all business in the Patent and Trademark Office connected therewith and to file, prosecute and to transact all business in connection with international applications directed to said invention:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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